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Project and group based learning and competition based evaluation in lesson of microcontroller applications

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Abstract

A process control which requires software and hardware has been given to students as a project study in microcontroller education. The class divided into groups of 2 student each and given names to each group. A temperature control which is the mostly used application of microcontrollers in industry has been chosen as the application. Various stages have been determined for facilitating to realize the project. Selections of equipments that will be used in application and writing of codes are performed by each group after the technical information given by the instructor. Students have behaved freely on their selections. On their selections by considering advantages and disadvantages they have endeavor to ensure supremacy for winning the race. Basic subprograms are presented to groups for controlling of the project with microcontroller and writing of code. Students may change these codes or add new codes. By running the projects in the same ambient the most correct running one is chosen as the first. The penalty points have been calculated considering constraints and rules. The first project is evaluated with the highest score. Projects of other groups are sorted by considering faults and running times of the projects. Scores of these groups are calculated by multiplying the standard deviation and a coefficient. Realization of the intended phases on time is added the evaluation. With group and project based working, the students have learned controlling of a process by using microcontroller, choosing convenient equipments to controller and realization of essential code. By means of this project, students have gained information and abilities necessary for industrial needs. Evaluation of the projects by a racing urges the student to a competition and increases success. Thanks to this microcontroller education, our students gain degree at national and international competitions based on microcontroller in various areas.

Keywords: Microcontrollers; project based education; group based learning; competition based evaluation;temperature control circuits.

1. Introduction

Last century information was being perceived as something would be gained. As a result of this, student instead of dealing with generative and active person position, he was passive and a recipient that memorizes the given information. Nowadays, the information is something being demanded and discovered. The principal aim of teaching is to bring the ability to access information than to give the available information. In this situation, student is not a person who memorizes given information. Student on education has a characteristic that active and seeking

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information. As a result of this learning has been come to forefront instead of teaching no more. Project based learning have been used in wide variety of the life area from secondary education to higher education. The students don't take information readily that learn to access information. In the learning process, the students learn active information (Korkmaz & Kaptan, 2001; Aydın, 2001). A lot of competitions have been made nowadays in parallel with technology being improved fast. Evaluation with competition and knowing to take prize when reached the success urge to the people to work. The person who wants to win the competition thinks creatively and work for doing one's best. A lot of universities agree with various foundations that arranges this kind of project competitions on national and international areas. Such as Asean University and JICA(Japan International Cooperation Agency) have arranged a competition including ten nations. Before the competition, the problem is introduced to students, the flow chart, block chart and some preliminary information has been given. With the help of competition very successful projects have been produced (Hara, Iwadate & Yamakita, 2007). In our country, the Ministry of National Education in cooperation with JICA arranges a robot competition each year. With these competitions, very original robot applications have been realized.

In this study, a microcontroller lesson which uses project based and group working method given on Technical Education and Engineering Faculty has been described.

2. Applications of Microcontroller Lesson

Microcontrollers are integrated circuits used in electronic circuit design mostly. Thanks to ALU, the microcontroller has the ability to perform mathematical operations and to evaluate the results logically. By means of this, without any change to hardware, by changing the software of the microcontroller, different jobs could be done (Taşdelen, Kutlu & Küçüksille, 1999). Owing to having analog to digital converter internally, it can be used to gather any kind of information and process them. Due to low cost and being small sized, they are preferred in embedded system designs. Thanks to loaded software, microcontrollers have unlimited applications areas.

Microcontroller lesson have been given as practical for well understanding. In the lesson, methods of project based teaching, group working, evaluation with competition are used. The subject of the lesson is expressed in the first week of the lesson. Information about how to do lesson and the problem supposed to be solved is introduced to the students.

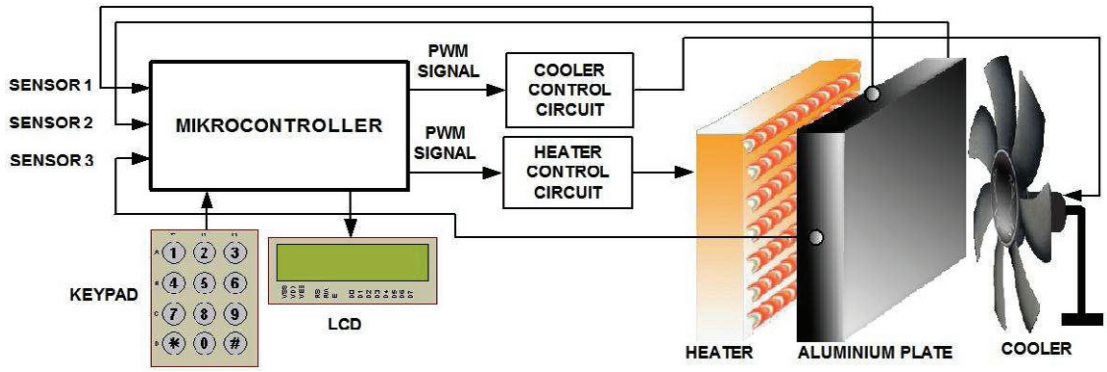

Figure 1. Block diagram of the system.

A temperature control which is the mostly used application of microcontrollers in industry has been chosen as the application. By using a microcontroller, an aluminum plate at the size of 100mm x 100mm x 10mm will be heated from the room temperature to 100 0C, it will wait at this temperature 5 minutes and then will be cooled down to room temperature again is determined as the problem. The goal is to work the determined project fast and effectively. Microcontroller, which will be used on the Project produced by Microchip, is PIC18F452. Because of low cost, high performance on logical operations, fast access to memory and data, running in high frequency, the PIC18F452 has been chosen.

Block diagram of the system is given simply at Figure 1. On the system three sensors have been used to measure the temperature. Sensors have been located at three different locations of the aluminum plate. Parameter values of

the PID (Proportional Integral Derivative) control method are entered by means of keypad. Temperature and values entered from keypad can be displayed on the LCD. PWM (Pulse Width Modulation) of heater and cooler circuits have been supplied by microcontroller. After definition of the problem, working plan has been done. Then classroom has been divided into groups of 2 students each. Grouping increases solidarity and information sharing while reducing workload. Grading system, penalty points and rules which each group has to be obeyed have been declared to students. The rules to be obeyed by each groups are:

- PID control must be used in software design.
- Dimensions of materials used in fan and coil for heating and cooling must not exceed the size of 10x10cm.
- System can be controlled by three or more temperature sensor.
- Designed circuit must be size of 10x15 cm max.
- Before starting the project, each group has to declare the type of sensor to be used, cooler type, heater type and other circuit components.
- During the competition, one repairing right is given to a trouble in the project.

If the students don't obey the rules, time will be added to total running time of the project. In case of not to be obeyed the rules; extra times to be added are as follows:

- Not to obey working calendar:2 s
- Change in components to be used, for each one:10 s
- Excess of size of heater, cooler; for each mm2:1 s
- Excess of size of circuits; for each mm2 :1 s
- Not to use PID control or faulty usage of PID; 100 s
- Proximity of the latest arrived temperature to 100 0C(|100- latest arrived temperature| x 5)s
- Invasion of waiting five minutes at 100 0C: 50 s
- Invasion of stopping the system after turning back to ambient temperature: 50 s
- Invasion of sensor numbers:100 s

Second, third and fourth week of the lesson, theoretical information about sensor, heater and cooler types are given. Advantages and disadvantages of these are mentioned. Types of sensors will be used in application have been given on Table 1. In the project to warm up aluminum plate, various kind of heating system like peltier, hot air and wire resistance can be used. For cooling of aluminum plate, peltier, CPU fan and gaseous cooler systems can be preferred.

Tablo 1 Sensors (Humpheris & Shhets, 1989).

Type/Name	Temperature Range	Linearity	Advantages	Disadvantages
Thermecouple	-273ºC-2000ºC	Good	Simple, Low cost, Rugged, Wide Range, Self Powered	Low Sensitivity, Reference Needed, Poor Stability
Thermistor	-100ºC-300ºC	Very poor	Small size, Low cost, High sensitivity, Fast response	Very nonlinear, Poor stability at high temperatures, Limited Range
RTD	-200ºC-800ºC	Good	Very stable, Very accurate, Linear, Wide Range	Slow response, Low sensitivity, Expensive, Self heating, Limited Range, Subject to thermal runaway
Semiconductor	-50ºC-150ºC	Poor	Inexpensive, Small, Output impedance high	
IC	-50ºC-150ºC	Excellent	Excellent linearity, Inexpensive, Very sensitive	Slow response

On the fifth week of the lesson, theoretical information about PID and simple code parts are given. PID codes are used in PWM control. Below some types of proportional control and sample code parts have been given. Students are introduced the control methods used in industry and learn advantage and disadvantage of the method. They learn how to develop codes about these and how to use systems. On-off controller or two level controller, Floating, Proportional controller, Integral controller, Proportional-Integral (PI) controller, Proportional Derivative (PD) controller, Proportional-Integral-Derivative (PID) controller; are samples of industrial controllers (Jakop, 1989).

With the simple code parts, students can test their own systems and checks for error in hardware. By joining given simple code parts, students build an entire code block. On the sixth week of the lesson, flow chart of the system is given. It is demanded that, the codes will be written should be developed according to flow chart given in Figure 2. When students running their own projects, it is asked on display that whether to change or not PID values.

If the PID values are changed, new values are entered using keypad. To start the project the start button is pressed. The system starts to heat aluminum plate. Whether reaching or not to 100 0C is tested by software. If aluminum plate reaches to 100 0C, it will wait 5 minutes at 100 °C. Then, cooler system switches on. It is controlled by software whether the temperature is back to ambient state or not. When aluminum plate reaches to ambient temperature the system is stopped.

On the eighth week of the lesson, the students are asked to declare materials which will be used on the project. Students make selections of materials by considering the advantages and disadvantages of the systems. The material list will be used are added to the file of each group.

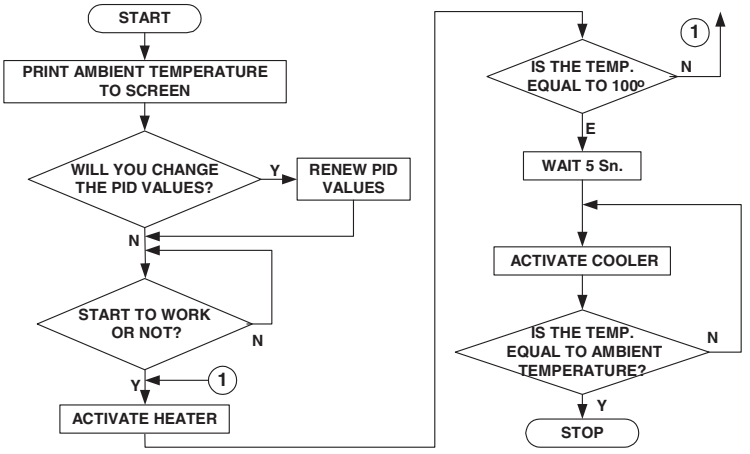

Figure 2. Flowchart of the system.

Oncoming week simulation of the system is realized in order. The simulation provides an observation of the problems which may be met in the real life. If deficient or wrong materials were chosen, they are changed in response to penalty point. Print circuit drawing, material providing, soldering and component combining are made sequentially. Problems are solved if any. System software is developed. After finishing all stages, the system is tested and tried to bring an optimum running point.

3. Evaluation

The Last week is the competition week. All groups bring their projects to the exam hall. One of the projects of the groups is given on the Figure 3. Before running the projects of all groups penalty points of the groups are examined. Competition order of the groups is determined by casting lots. All groups run their projects in order. Running time of projects is calculated. During the project, penalty points resulting from the invasion of rules and other penalty points are added to total running time of the project. Score of the project which has the shortest running time is determined as 100 points. Evaluation is done using equation 1. Where A is First project score, t is running time of project whose point will be calculated, x is group point. All the running time of projects and evaluations of the projects are given on the table 2.

$$x = (A \cdot 100) / t \qquad \text{(Equation 1)}$$

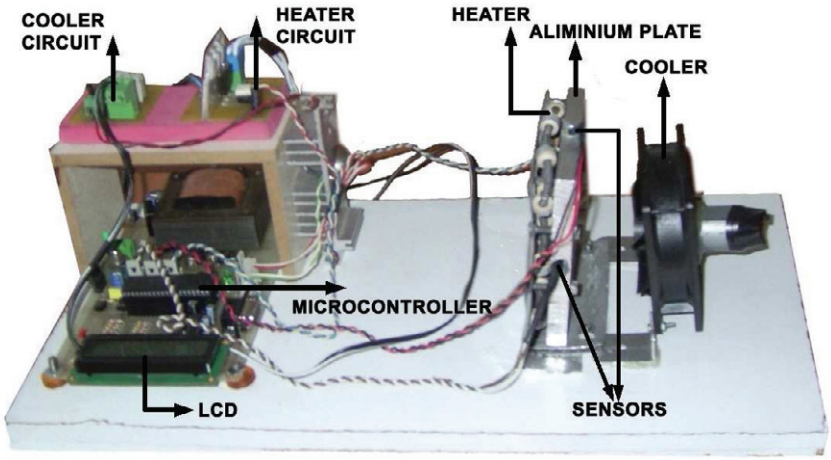

Figure3. A finished project (group of betem).

Table1. Results of competition.

No	Group name	Sensor Type	Heater Type	Cooler Type	Size of circuit	Work table	Material adding or subtraction	Heating process	Waiting process	Cooling process	Stopping process	Total Process Time	Total time (sn)	Ranking	Grades
1	TAKA	IC	Wire Resistance	Cooler system	57	24	40	0	50	150	0	586	**907**	**9.**	**75**
2	A² DESIGN	Thermistor	Peltier	CPU fan	65	30	20	60	0	100	50	369	**694**	**2.**	**98**
3	BETEM	Thermistor	Wire Resistance	CPU fan	23	43	10	50	50	50	0	530	**756**	**3.**	**90**
4	YAREN	IC	Wire Resistance	Fan	36	56	30	90	0	50	50	368	**680**	**1.**	**100**
5	GAMAR	IC	Resistance	Fan	87	46	20	80	50	0	50	467	**800**	**6.**	**85**
6	YURTTAŞ	Thermistor	Wire Resistance	CPU fan	123	34	40	60	0	100	0	416	**773**	**4.**	**88**
7	HOTCOLD	Thermistor	Resistance	CPU fan	54	35	10	80	50	150	50	1271	**1700**	**11.**	**40**
8	RÜZGÂRGÜLÜ	IC	Wire Resistance	CPU fan	45	25	20	40	50	100	0	502	**782**	**5.**	**87**
9	ISTANBLUE	Thermistor	Resistance	Fan	54	32	40	110	0	50	50	710	**1046**	**10.**	**65**
10	GRUPİKİLİ	Thermocouple	Wire Resistance	Fan	87	21	20	90	50	50	0	511	**829**	**7.**	**82**
11	GAZOZ	RTD	Wire Resistance	CPU fan	104	32	10	100	50	100	50	426	**872**	**8.**	**78**
12	FIREOFFICE	Semiconductor	Resistance	Fan	47	35	30	30	50	50	0	587	**829**	**7.**	**82**
13	RECLUSE	Thermistor	Resistance	CPU fan	65	34	40	50	0	0	50	534	**773**	**4.**	**88**
14	DREAMPROJECT	Thermistor	Wire Resistance	CPU fan	71	26	20	20	50	150	0	427	**764**	**3.**	**89**

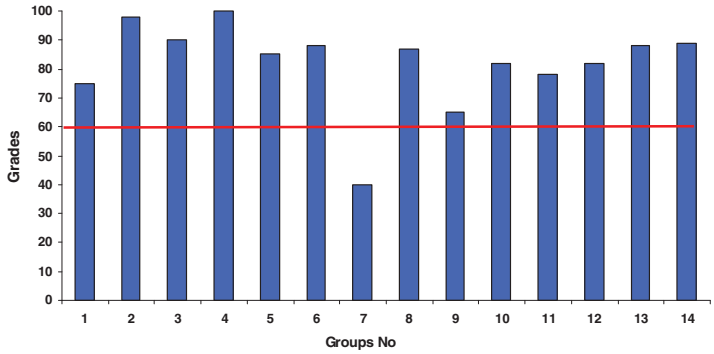

Figure 4. Results of exam

4. Conclusion

Consequently, project based education and competition method used for evaluation of the project are successfully applied to the microcontroller applications lesson. All of the groups have worked to realize the best project and thanks to these efforts they had a great deal of knowledge about the microcontrollers (Figure 4). But only one group didn't take enough grades. All groups have obtained experience about choosing and using materials. By means of means of given education, students gain degree at the national and international competitions based on microcontrollers in various areas.

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